The mental representation of materials distilled from > 1.5 million similarity judgements

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Question

- Massive variety in material appearance
- What are the **core feature dimensions** of our robust mental representation?

STUFF Database

- 200 material concepts from the English language (Hebart et al., 2019)
- 3 close-up photos each

Rationale and Task

- **Dimensions** should be (i) predictive of behavior and (ii) interpretable
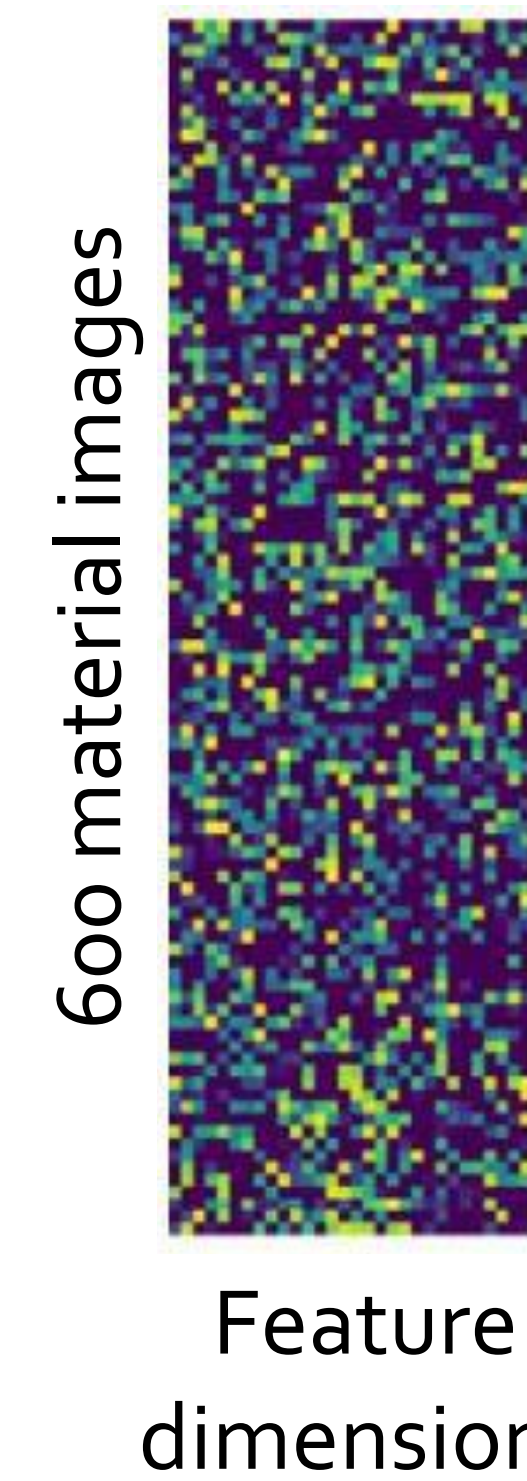- Triplet 2-AFC task (1.8m resp @MTurk)
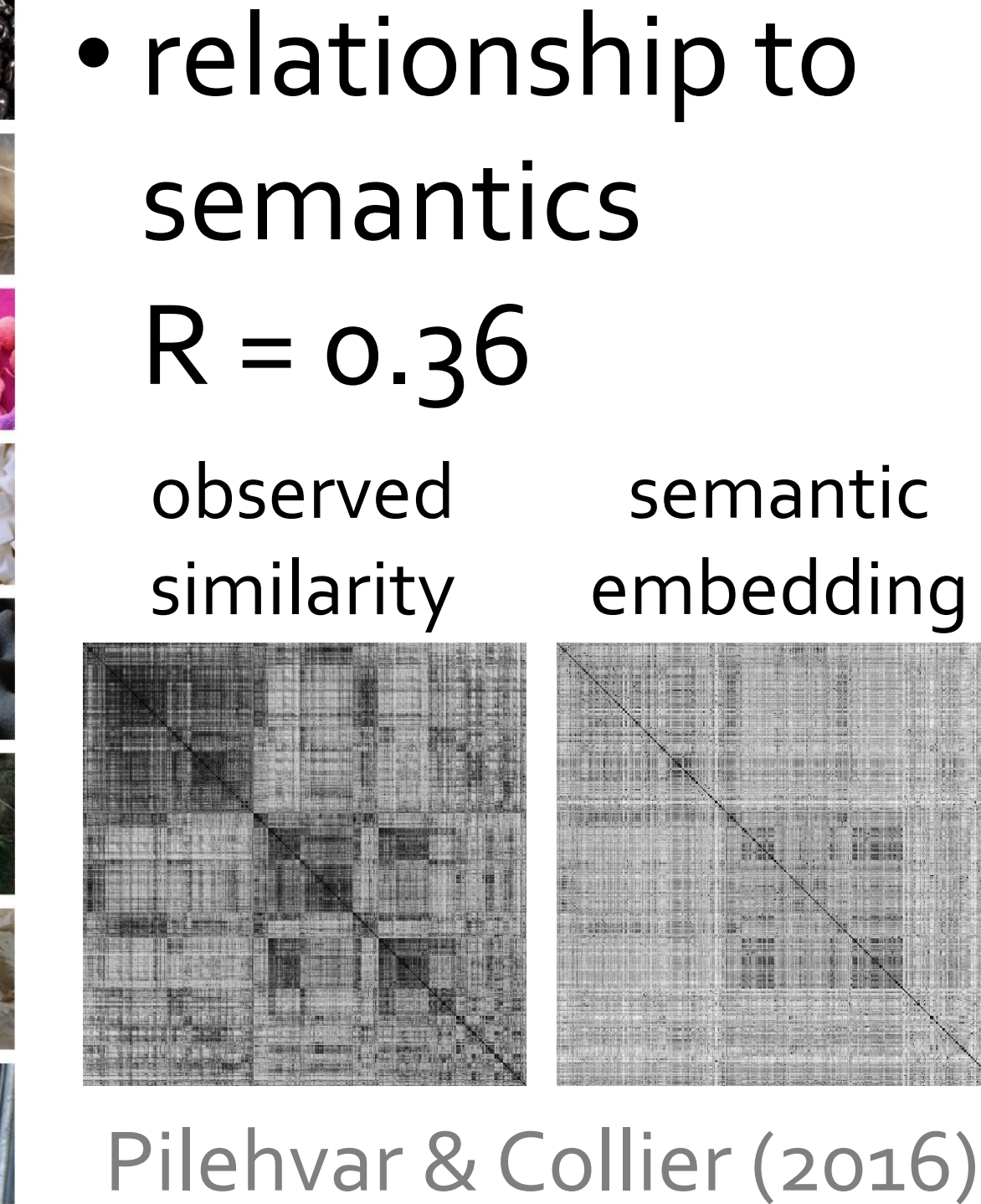

Select the most similar to the top reference

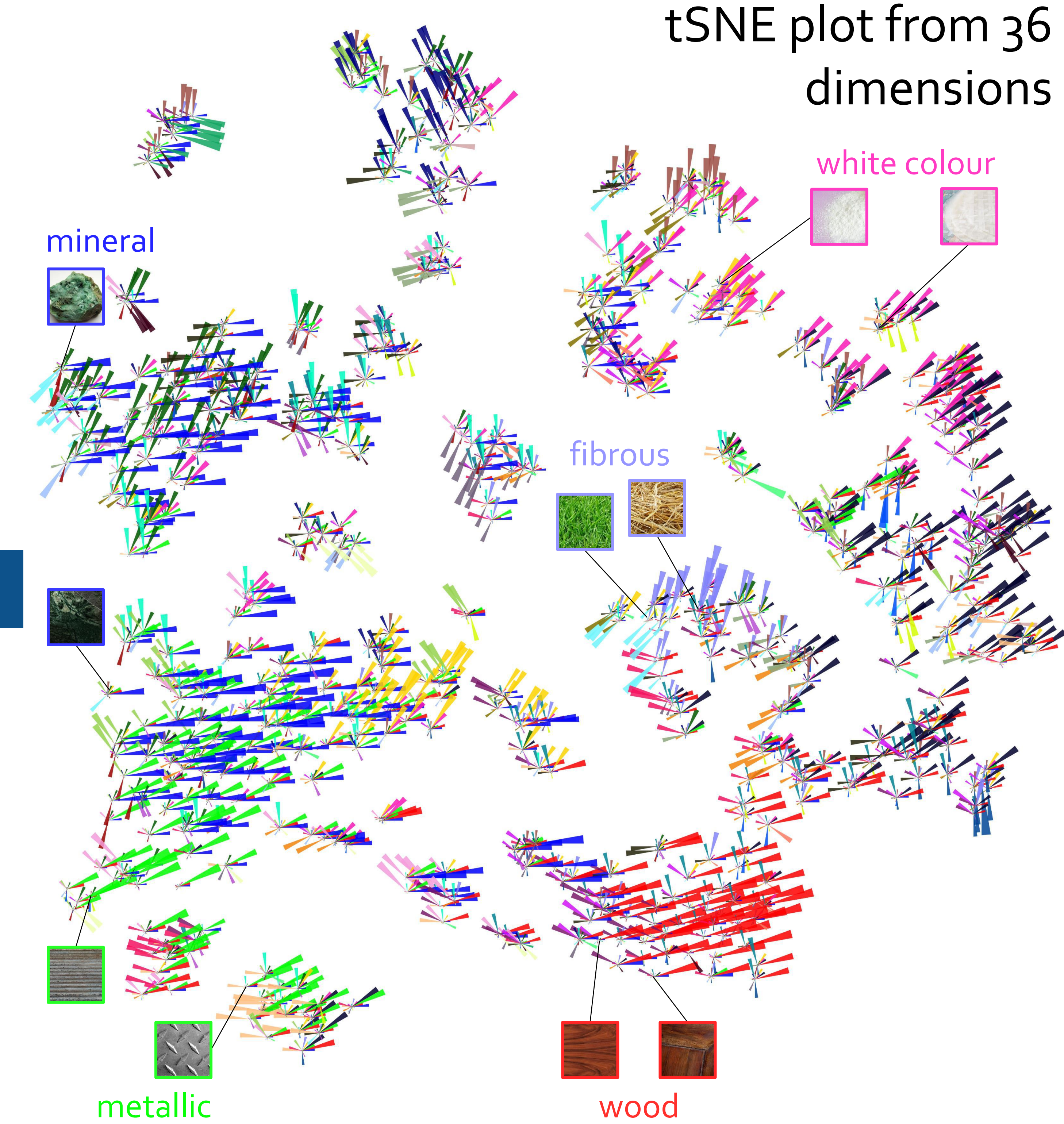Vary images to sample across a wide range of contexts

Modeling

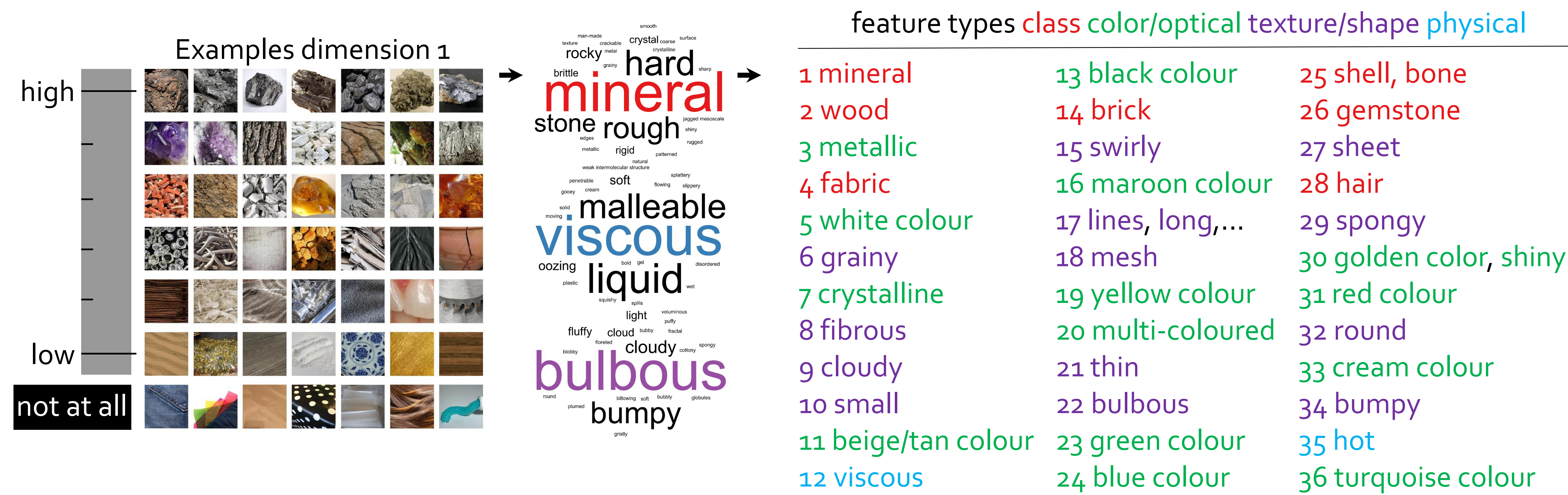

600 material images

Feature dimension

- Representational embedding (Hebart et al., 2020)
- Assumptions: dimensions are (i) sparse, (ii) continuous, (iii) positive
- Best model: **92% accuracy** w/ respect to noise ceiling (74%), **36 dimensions**
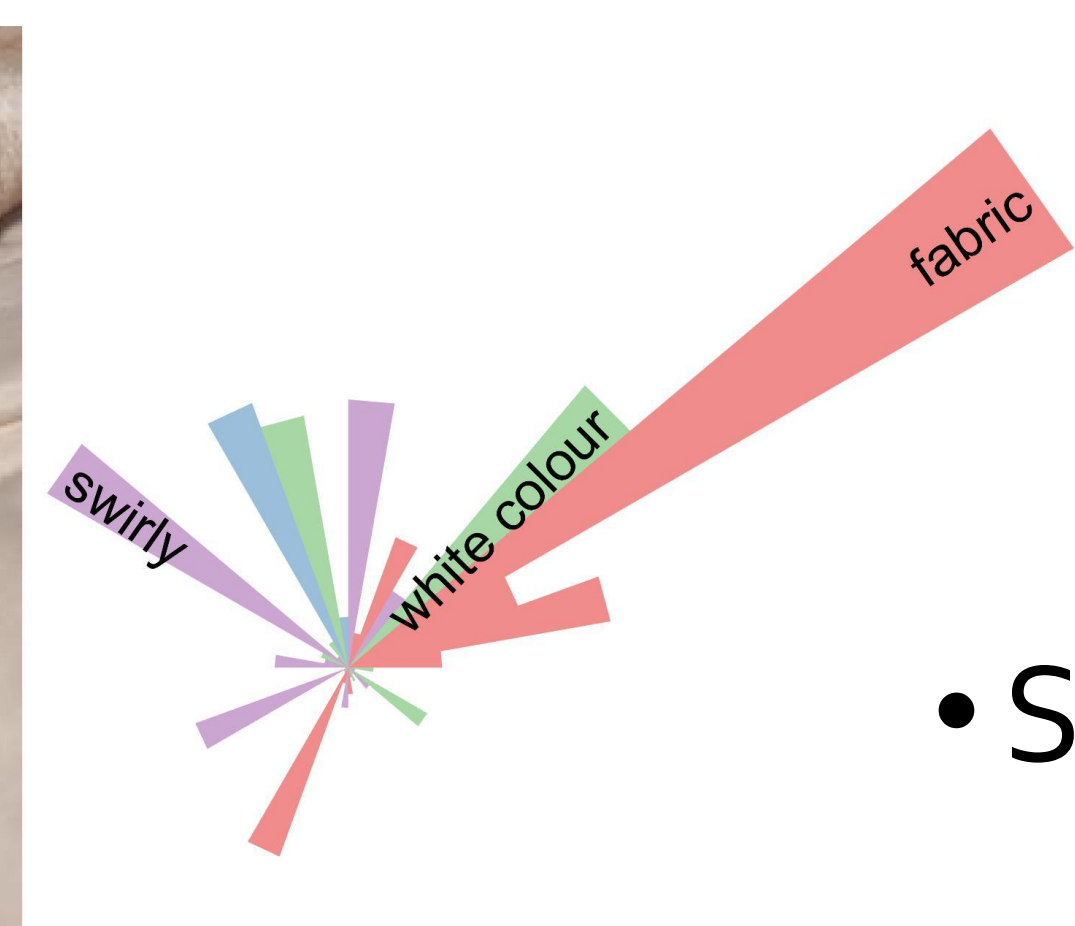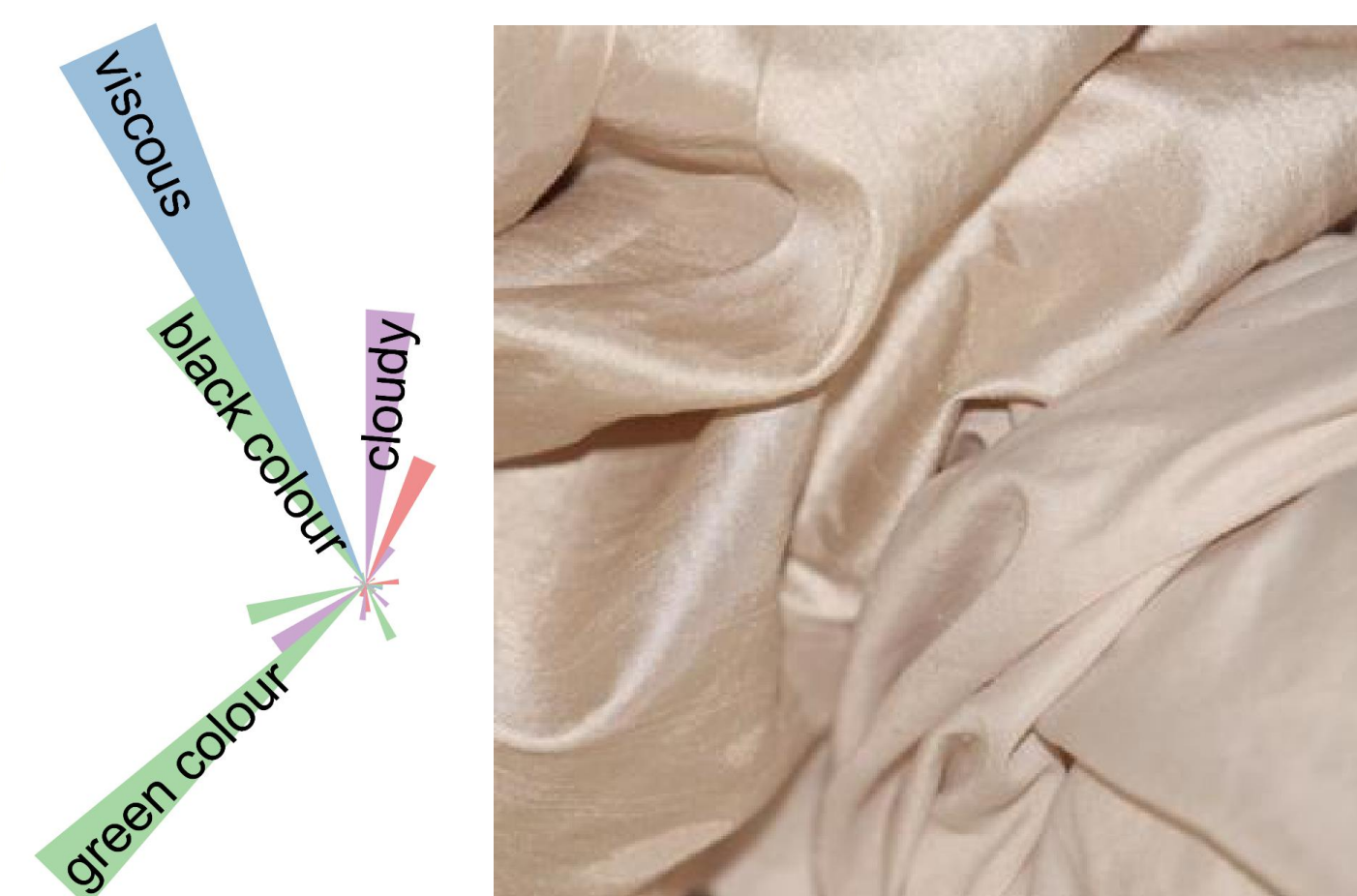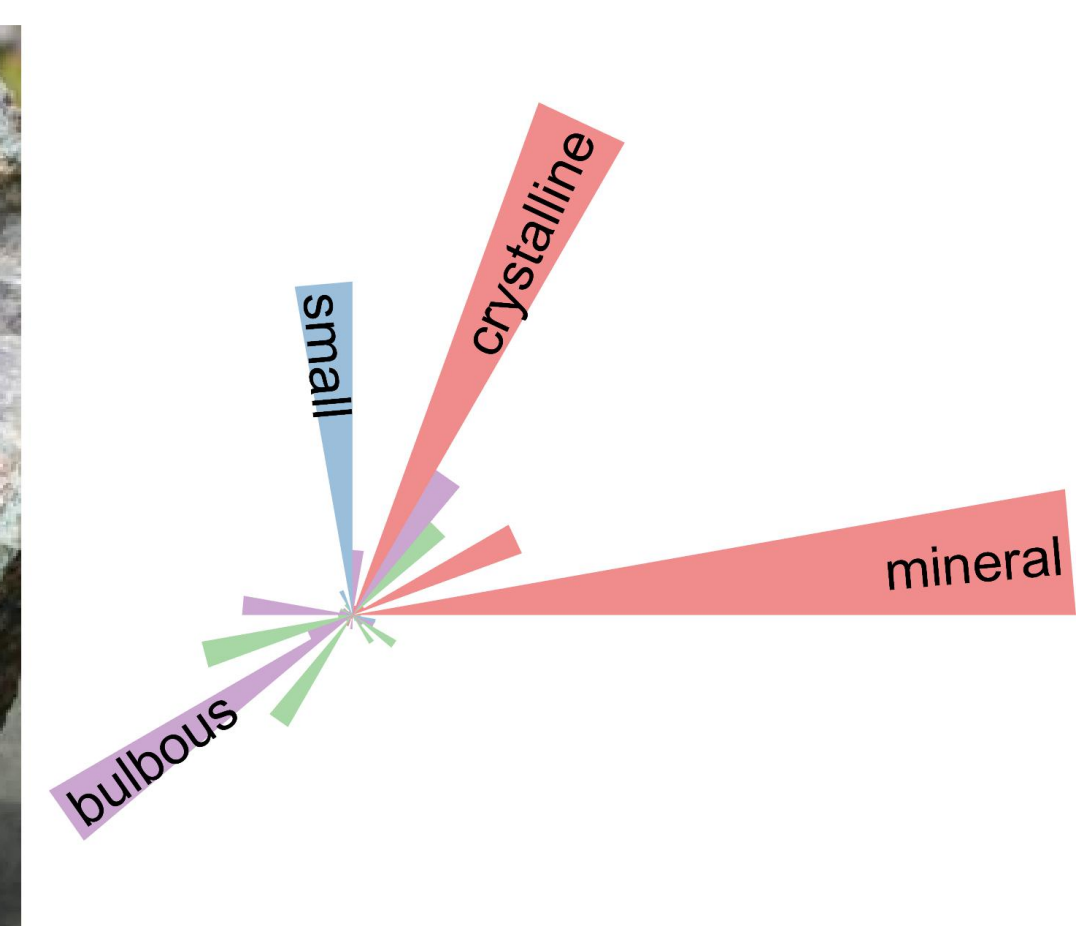
36 Core Feature Dimensions

Examples dimension 1

high

low

not at all

feature types: class · color/optical · texture/shape · physical

1 mineral	13 black colour	25 shell, bone
2 wood	14 brick	26 gemstone
3 metallic	15 swirly	27 sheet
4 fabric	16 maroon colour	28 hair
5 white colour	17 lines, long,...	29 spongy
6 grainy	18 mesh	30 golden color, shiny
7 crystalline	19 yellow colour	31 red colour
8 fibrous	20 multi-coloured	32 round
9 cloudy	21 thin	33 cream colour
10 small	22 bulbous	34 bumpy
11 beige/tan colour	23 green colour	35 hot
12 viscous	24 blue colour	36 turquoise colour

- 5 to 9 dimensions are needed to predict individual trials with 95-99% accuracy

Results

- relationship to semantics R = 0.36

observed similarity

semantic embedding

Pilehvar & Collier (2016)

Most similar categories

Least similar categories

tSNE plot from 36 dimensions

white colour

mineral

fibrous

metallic

wood

Conclusions

- Our model is well **predicting behavior**
- **36** core feature **dimensions** reflect **perceptual and conceptual** material properties
- Step towards learning the **internal mental representations of materials**